The 1996 Outburst of GRO J1655–40

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During 1996 the soft-X-ray transient (SXT) and superluminal jet source GRO J1655–40 was observed in outburst with a multiwavelength campaign including *HST*, *RXTE*, *CGRO* and ground based facilities. The light curves for the outburst are shown in Fig. 1a. Most striking is the sustained X-ray rise, while optical and ultraviolet fluxes were decaying. This is contrary to standard models of SXT outbursts (e.g. Cannizzo, Chen & Livio 1995), and difficult to reconcile with the common view that the optical radiation arises from reprocessing of X-rays by the disk and/or secondary.

In the optical, the dereddened *HST* spectra (Fig. 1b) do not show the $f_\nu \propto \nu^{1/3}$ form expected of a steady state accretion disk and previously seen in X-ray Nova Muscae 1991 (Cheng et al. 1992). Instead it is dominated by a redder component which can be characterized by the best-fitting black body. Roughly we see a fixed temperature emitter ($T \sim 9000\,\mathrm{K}$), shrinking in area from 5.0 to $2.2{\times}10^{23}\,\mathrm{cm}^2$. The maximum area is a little larger than the projected disk area, but as some of the optical flux will be originating on the secondary, this is not inconsistent.

This fixed temperature/shrinking area behavior is suggestive of the inward propagating cooling wave predicted by the DIM (Cannizzo et al. 1995) and the temperatures we infer are consistent with material marginally in the hot state of that model. The part of the disk in the hot state is normally expected to have a temperature distribution and spectrum similar to a steady state disk (i.e. $f_\nu \propto \nu^{1/3}$). GRO J1655–40, however has a longer orbital period (hence larger disk) than most SXTs, so that there exists *no globally stable steady state*

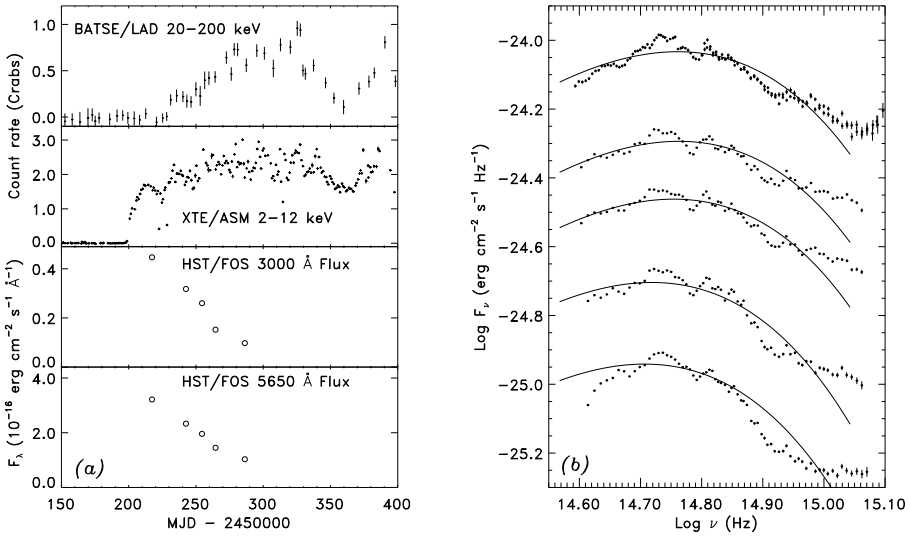

Figure 1. a) Light curves of the outburst, spanning 1996 Mar 8 to Nov 13. b) Evolution of the *HST* spectra, with best fitting black bodies overlaid. A successive downward shift of 0.1 has been applied to each spectrum below the first to separate them clearly. The wavelength range of this figure is 8500 Å (left) to 2400 Å (right).

solution for sub-Eddington accretion rates. We would therefore expect a different temperature distribution in this case. The sustained X-ray rise is harder to reconcile with the DIM, but may also be a consequence of the large size of the disk.

We have here discussed only one interpretation of the data; an alternative source of the optical radiation that we have considered is synchrotron emission. This, and other issues raised by this dataset are discussed in Haswell & Hynes (1997) and a more comprehensive analysis is presented in Hynes et al. (1997).

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References

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